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THE RELATIONSHIP BETWEEN HORIZONTAL AND VERTICAL PHORIA MEASUREMENTS*

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The writer wishes at the outset to make it clear that what is presented in this paper is not intended as a conclusion of facts but merely an effort to acquaint those who may be interested in a line of reasoning which he has followed during the past year. It is hoped that a reasonable amount of discussion may decide the wisdom or folly of its reliability.

The basic thought which prompted the efforts delegated to this problem was embodied in the following inquiry: "If it is reasonable to establish a binocular condition of accommodative rest (or whatever terminology may be used to express that state of minimal accommodative activity), when correcting the refractive error of an eye so that the entire amplitude of accommodation may be reserved for other than remote ocular application, why is it not equally reasonable to employ prismatic elements to establish the direction of the visual axes of the two eyes so that the convergence function may be equally in a state of poise with that of the accommodative function"

The question itself seems reasonable enough but the choice of an avenue of attack is fraught with uncertainty.

It seems proper, however, since the question involves an accepted practice as a basis for comparison, that we first investigate the resultants of the accommodative function when the refractive corrections establish a minimum refractive status of the eyes for distant object application.

Much that is involved in this preliminary problem was presented by the writer during the past fifteen years under the title of Lens Effectivity in lectures before optometric societies and through articles in the optometric press, and only the most salient factors will be herein rehearsed.

In the first place it must be understood that light received by an ametropic eye must be incident to that eye with a convergence or divergence equivalent to its error. In other words if an eye is 1.00 D. hyperopic it must receive 1.00 D. of convergence.

*An abridgement of the material presented before the American Academy of Optometry at Philadelphia, December 8, 1931.

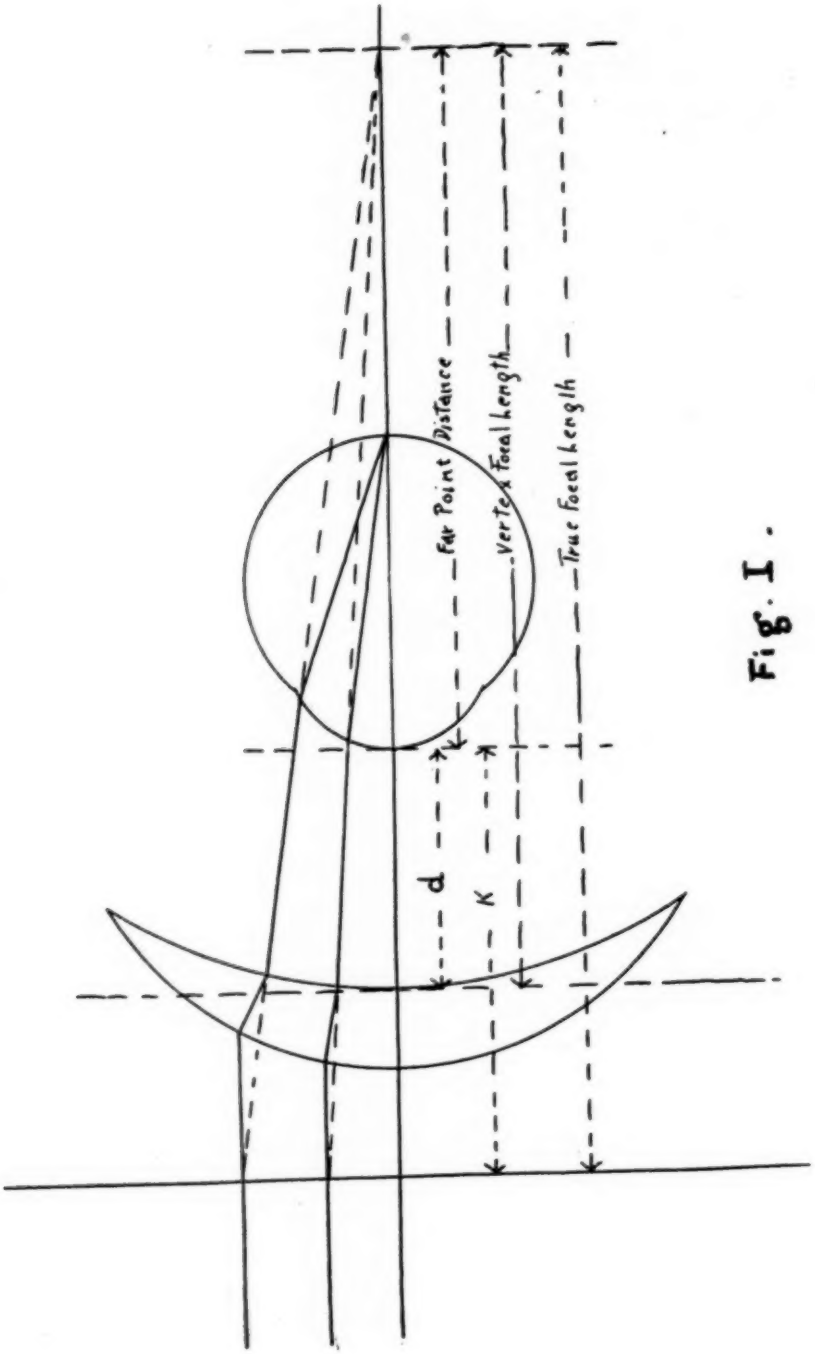
Far Point Distance
Vertex Focal Length
True Focal Length
d
K

Fig. I.

It will be noted that in Figure I the figure D, the true dioptral power of the correcting lens, is the value of the vergence of the pencil of light created by the lens, noted in the second principal plane of the lens. Likewise D_V and D_E represent vergence values of this same pencil of light noted respectively in the back surface plane of the lens and the corneal plane of the eye.

Because D_E represents the vergence equivalent required by an eye to permit its establishing a focus on the retina while the eye is in its minimum state of refraction, it also signifies the quantitative equivalent of the ametropia on the basis that it represents the necessary alteration in the relative direction of the rays of light emanating from a point object at a remote distance to permit the aforementioned retinal focus. Conversely it may also be said that D_E represents the maximum convergence and minimum divergence of light rays for which an eye may adapt itself.

Secondly we must not overlook the fact that there is a purely physical cause for the variabilities of the accommodative efficiency when objects at near distances are observed through correcting lenses.

From Fig. II we may deduce the fact that, since two unlike pencils of light will have unequal variations in their vergence values through a given interval, $D_E - D_N$ cannot be equal to $D - I_V$. But $D_E - D_N$ is equal to the accommodative adjustment required by the eye to adapt itself for the pencil of light originating in the object at O. Thus if D_E represents the vergence value for which the eye is adapted when in its minimum state of refraction and D_N the vergence contribution presented from an object placed at the nearest distance at which it may be seen through the correcting lens then $D_E - D_N$ equals the amplitude of accommodation.

Let O be an object and O_V the vergence value of the object pencil; I_V represents the vergence value of the image pencil and D_N represents the vergence contribution to the eye for which the eye must adapt itself in order to focus an image of the object at O. K equals the interval from the eye to the second principal plane of the lens. (The first principal plane has been ignored in these calculations for the reason that its consideration does not sufficiently add to the accuracy of the solution of the problem.)

By the application of geometric optics we obtain the following formulae:

$$(1) \quad D_E = \frac{D}{KD + 1}$$

$$(2) \quad D_N = \frac{1 + D\ (u - K)}{u + KD\ (u - K)}$$

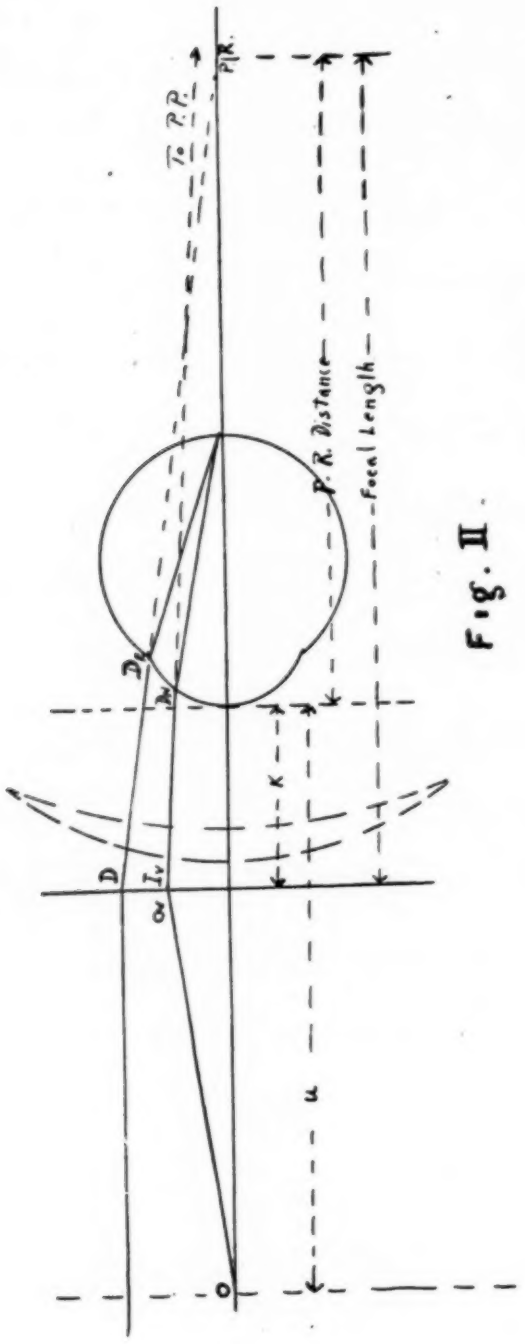

Fig. II.

$$(3)\quad D_E - D_N = \text{Accommodative Requirement}$$

$$(4)\quad \text{Ac. Req.} = \frac{-1}{(KD + 1)\ [u + KD\ (u - K)]}$$

Note: In the above as well as in subsequent formulae written in this treatise u and K represent negative numerical equivalents and must be expressed in decimals of the meter.

Thus with formula number four we may calculate the accommodative requirement for any lens at any given distance from the eye and for any object distance. It is significant that for fixed K and u distances the accommodative requirement increases in a reasonably uniform arithmetic progression as the D values are increased. For example when we choose an object distance of 40 c/m and place the lenses so that their second principal planes are 2.5 c/m from the cornea we find for plus lenses that each diopter of power necessitates an accommodation requirement which is ⅛ D. in excess of that which the emmetrope would require for the same distance.

With this as the basis of our accommodative requirement analysis we may now proceed to study the convergence requirement.

Since both our accommodative and convergence requirements deal specifically with lenses that are accurately centered for distance adaptation the visual axes must deviate from the principal axes of the correcting lenses when the eyes are binocularly applied to some near object.

Applying our analysis in its simplest form we will refer to Figure III in which we will note that as the visual axes are directed through joints F and F′ the eyes will be receiving rays of light originating from a point O in the median plane. Or in other words, to see an object at a distance u and located in the median plane, the eyes must converge to the point I when the lens D is of plus power. For myopic corrections both the accommodative and convergence requirements are less than those required by the emmetrope for the same distance.

From Figure III we may derive the convergence formula by the following process:

$$\frac{HI}{MN} = \frac{GI,}{GL} \qquad \frac{FG}{HI} = \frac{GO,}{IO} \qquad \frac{EF}{GF} = \frac{AE}{IG}$$

NOTATION REGARDING FIGURE III, PAGE 160.

In this diagram AP equals the distance from the center of Rotation to the corneal plane and represents a negative numerical equivalent. MN in centimeters represents the prism-dioptral equivalent of the displacement suffered at F. The purpose of the diagram is to provide a means for deriving an equivalent for CI or V which is the practical convergence distance and the reciprocal of which expresses the meter angles of convergence required.

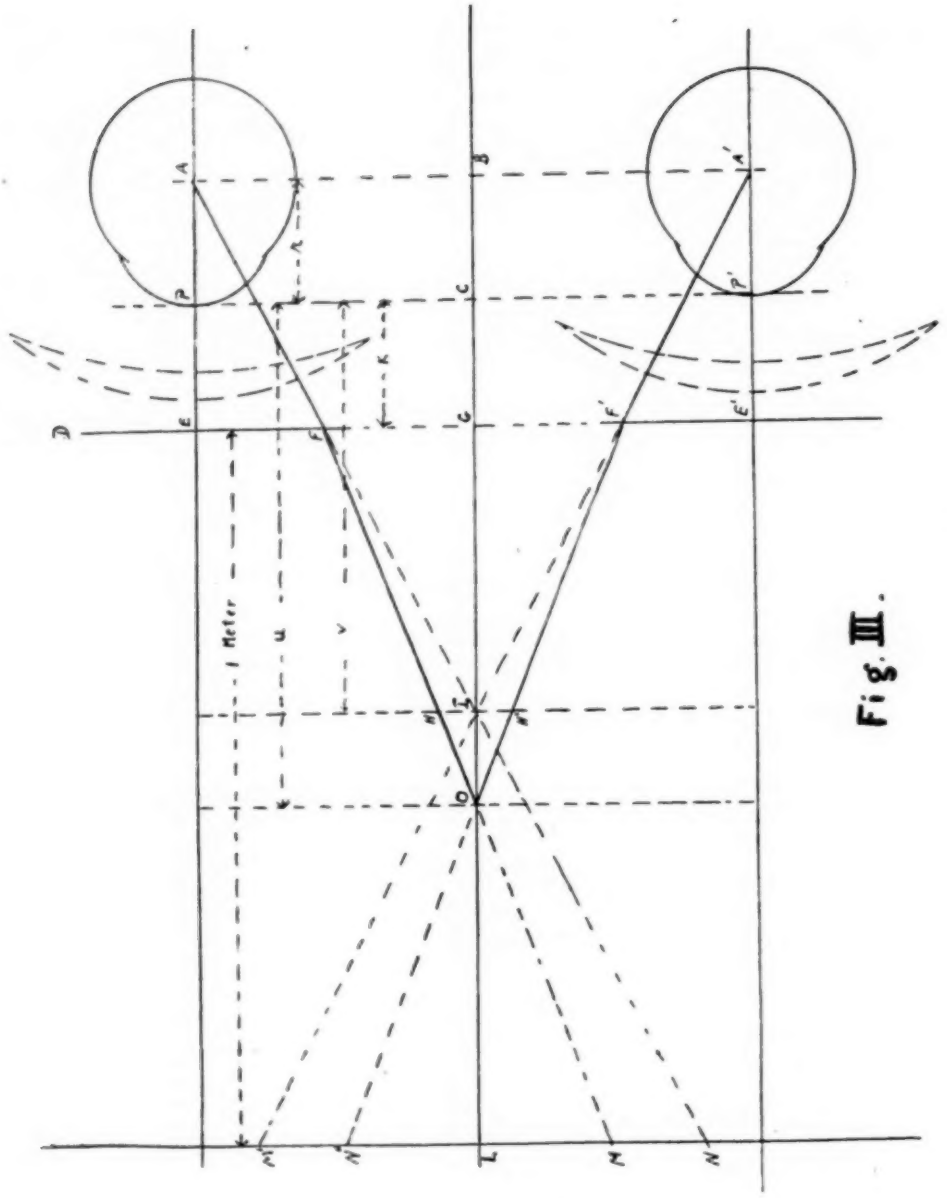

Fig. III.

(See notation. page 159.)

Multiplying these three equations by each other we have:

$$\frac{HI \times FG \times EF}{MN \times HI \times GF} = \frac{GI \times GO \times AE}{GL \times IO \times IG}$$

$$\frac{EF}{MN} = \frac{GO \times AE}{GL \times IO}$$

Furthermore since $EF \times D = \Delta$ and $\frac{MN}{EF} = \frac{\Delta}{1}$

Therefore $EF \times D = MN$ or $\frac{EF}{MN} = \frac{1}{D}$

$$\text{Thus } \frac{1}{D} = \frac{GO \times AE}{GL \times IO}$$

Remembering that linear measurements, when associated in equations with dioptral elements, must be expressed in decimals of a meter, GL equals unity (—1), $IO = u - V$, $GO = (u - K)$ and $AE = (r + K)$. By substitution we have

$$\frac{1}{D} = \frac{(u - K)\ (r + K)}{-(u - V)} \qquad \text{solving for V}$$

we have $$V = D\ (u - K)\ (r + K) + u$$

and since the meter angles of convergence are equal to the negative reciprocal of the convergence distance or convergence requirement in meter angles $= -\frac{1}{V}$ we have

$$(5) \quad \text{Con. Req.} = \frac{-1}{u + D(u - K)\ (r + K)}$$

(In the use of this formula r may be arbitrarily taken to equal —.01 meters without materially affecting the result of the equation.)

Carrying our thought one step further we may express the accommodative-convergence ratio which may be established by any lens correction. All that is necessary is that we divide equation 4 by equation 5 and we have:

$$\frac{\text{Ac. Req.}}{\text{Con. Req.}} = \frac{u + D(u - K)\ (r + K)}{(KD + 1)\ [u + KD(u - K)]}$$

However for practical purposes it will be far more satisfactory to refer to the following table which represents the various conditions met

with when the application of accommodation and convergence is required through correcting lenses.

Tabulation of DV, D, DE, and DN values as they are associated with accommodative and convergence requirements and the corrective spheric and prismatic additions indicated for normal functioning.

DV	D	DE	DN	Ac. Reg.	Con. Reg.	Sph. Add.	Pr. Add.
+ 1.00	+ .98	+ 1.02	— 1.66	2.68	2.60	+ .12	.25 Δ in
+ 2.00	+ 1.97	+ 2.07	— .68	2.75	2.67	+ .25	.5 Δ in
+ 3.00	+ 2.93	+ 3.15	+ .27	2.88	2.76	+ .37	.75 Δ
+ 4.00	+ 3.87	+ 4.27	+ 1.24	3.03	2.86	+ .50	1. Δ in
+ 5.00	+ 4.81	+ 5.43	+ 2.27	3.16	2.95	+ .62	1.25 Δ in
+ 6.00	+ 5.73	+ 6.64	+ 3.29	3.55	3.06	+ .75	1.50 Δ in
+ 7.00	+ 6.62	+ 7.88	+ 4.38	3.50	3.17	+ .88	1.75 Δ in
+ 8.00	+ 7.47	+ 9.17	+ 5.46	3.71	3.31	+1.00	2. Δ in
— 2.00	— 1.98	— 1.94	— 4.33	2.35	2.41	— .12	.25 Δ out
— 4.00	— 3.98	— 3.76	— 6.00	2.24	2.28	— .25	.75 Δ out
— 6.00	— 5.98	— 5.47	— 7.57	2.10	2.18	— .50	1.25 Δ out
— 8.00	— 7.98	— 7.09	— 9.07	2.02	2.09	— .75	1.25 Δ out
—10.00	— 9.99	— 8.62	—10.49	1.87	2.00	— .87	2. Δ out
—12.00	—11.99	—10.06	—11.85	1.79	1.93	—1.12	2.50 Δ out
—14.00	—13.99	—11.44	—13.12	1.68	1.85	—1.36	3. Δ out
—16.00	—16.00	—12.74	—14.33	1.59	1.79	—1.50	3.25
—18.00	—18.00	—13.97	—15.50	1.53	1.72	—1.75	3.50 Δ out
—20.00	—20.00	—15.15	—16.61	1.46	1.67	—2.00	4. Δ out

In referring to this table it must be borne in mind: first, that a near object distance of 40 c/m has been applied; second, that the distance from the cornea to the back surface of the lens has been arbitrarily assumed to be 1.6 c/m; third, that only corrected lenses have been considered for the reason that they provide greater efficiency refractively and because they cause slightly less excess accommodation and convergence requirement; fourth, that the tabulations of spheric and prismatic additions have been approximated to the nearest eighths and quarters; fifth, that the prismatic addition is based on a 64 m/m P.D.

If optometric practice consisted only of a purely physical and mechanical problem and this comprised merely the determination of the error of refraction and the application of lenses as compensatory agents, we might well say that a complete understanding of the formulae and table thus far presented, included all of the requisites of the successful practice of optometry.

This is however the mere beginning of our analytical processes in our attempt at solving the problems of abnormal binocular vision and we find ourselves again faced with the interjection, "All of the foregoing applies very nicely to all of the cases in which accommodative

relaxation responds satisfactorily to refractive correction and at the same time there exists either a normal-habitual-convergence-accommodation or the convergence adaptations per se are elastic enough to permit binocular fixation to be comfortably accomplished regardless of the primary association of fixation and minimal accommodation."

The last clause of this interjection brings us face to face with our real problem which is, "What is abnormal primary association of fixation and minimal accommodation, how may we take its measure, and what corrective means shall be employed?"

Any one of the three parts of this question might lead to an extended discussion but to the writer it appears that the first and third parts of the question lend themselves to a tolerant assumption as a basis upon which we might proceed, namely, that abnormal primary fixation and minimal accommodation relationship is that condition in which the visual axes are not in parallel relationship when the accommodation is in its minimal state of adjustment or that state in which clear binocular imagery of distant objects may only be maintained when fusion is accomplished with effort.

An effortless fusion accomplishment for distant application may be assumed to constitute the normal primary fixation and minimal accommodation relationship for a pair of eyes and that this is the goal in optometric practice.

With due consideration for the compensatory faculties provided physiologically and psychologically the third part of the question is merely a problem in lens effectivity.

It is the second part of the question with which the writer finds himself particularly concerned. True enough, it is a question of phoria measurements and if we accept the term phoria as it is generally accepted and make the measurements thereof in the, at present, accepted manner we may see little problem in this question.

We say, generally speaking, that a phoria is the tendency of the visual axes to deviate from the required fixation alignment and that it is overcome by the urge of fusion.

Might we not also say that it represents the tendency of the visual axes to assume their primary fixation position when the refractively corrected eyes are applied to distant objects or it represents the tendency of the visual axes to assume their associated direction of poise with a certain accommodative activity?

We must allow this question if we at all agree that heterophoria is physiologically and/or psychologically induced through the association of accommodation and convergence; physiologically perhaps because of a definite ratio of nervous energy distribution to the two functions and psychologically because of suppressed fusion or constrained habit.

Let us now investigate the manner in which phoria measurements

are made. Many of us can remember using the Stevens phorometer which consisted of two five diopter prisms whose bases were in opposite direction. Making our measurements at six meters we gave little heed to the fact that their displacement powers at the working distance was 60 centimeters or 24 inches or approximately two-thirds of this when the eyes were exerting their full duction effort with the prisms in vertical position.

The maddox rod was used extensively for a time and at present some claim results by using the red and green filters.

It is assumed that the majority of refractionists at the present use the von Graefe test or a modification thereof, consisting of a simple prism eight to ten diopters as advocated by its advocate or as low as a four diopter prism as experience caused the modification to be made.

What we actually measure by this method is nothing other than a manifestation of the direction of the visual axes under a condition of maximum duction application in a given direction during a, perhaps, definite accommodative adjustment, might be a reasonable assumption.

The "perhaps" is inserted purposely because it has been found that where the minimum dioptral quantity of vertical or horizontal prism power which caused diplopia was placed before a pair of eyes, the displacement of the image, first of all, was variable and secondly, that the increased displacement caused by additional prism power was not equivalent to six centimeters per diopter as we would geometrically assume it should be. Interestingly enough it was found to be sometimes more and other times less than this.

Faced with these factors the writer determined to tabulate a series of manifestations provided by a series of prisms from one to five diopters placed first base-down and second base-up before the dominant eye.

The selection of the dominant eye was arbitrary but encouraged by the knowledge that refractively, prisms affect the definition of the retinal imagery and practically that perhaps less exageration would be encountered in the findings.

The determination to employ the prisms with their bases both down and up was induced by the fact that experimentally it has been found that the manifestations will vary, depending upon the direction of the base of the prism.

For the purpose of making the tabulations a card such as is illustrated in Figure IV was devised.

The tabulations will provide notations of vertical separation caused by the prisms and the manifest phoria, if any, for each prism power both for distance and near. In addition the card provides a means for classification according to type and degree of refractive error.

It will be noted by those who will follow this scheme of tabulating the visual axes tendencies that in some instances the vertical separa-

Name John Doe Date Jan 23/32

Date of Rx worn	Emmet O.D. O.S.	Hyperop O.D. O.S.	Myope O.D. O.S.	Simp Hy As O.D. O.S.	Simp My As O.D. O.S.	Comp Hy As O.D. O.S.	Comp My As O.D. O.S.	Mixed As O.D. O.S.
Dec 5/31						1.50 2.50		

Vertical Prism over O.D. — O.S. — O.U. —	6 Meters (20 Feet) Vertical Separation in Prism D.	Manifest Eso-phoria in Prism D.	Manifest Exo-phoria in Prism D.	40 c/m (13 Inches) Vertical separation in Prism D.	Base-out alignment Prism required	Base-in alignment Prism required
1.Δ down	✓			✓		
2.Δ "	✓			✓		
3.Δ "	✓			1		1 F
4.Δ "	1		1	2		8
5.Δ "	2		1	4		15
1.Δ up	✓			✓		
2. "	✓			✓		
3. "	1		1	✓		
4. "	2		1	2		10
5. "	3		1	4		15

Remarks:-

Fig. IV.

tion is eliminated when the horizontal prism is inserted to measure the esophoria or exophoria. In such cases the notation under manifest phorias should have a letter F appended.

Care must be exercised in making these measurements to have the correcting lenses perfectly centered both horizontally and vertically to eliminate the possibility of prismatic involvement caused by the correcting lenses. This centering applies to distant measurements and should be left in this adjustment for near measurements as well. In the case of presbyopes the reading addition should be inserted before measurements are made and the pupillary distance adjusted to approximate that which would be met with in the bifocal corrections, if such are to be worn.

To simplify the process of noting the vertical separations and manifest phorias the employment of a pair of cards as shown in illustrations V and VI will conserve much time.

Figure V represents the diagram to be used for distant application. The line of this diagram should be approximately 2 m/m in thickness and the vertical lines separated by intervals of 6 c/m. The length of the vertical lines from left to right should be 6, 12, 18, 24, 30 centimeters.

With this chart hung at six meters from the patient the vertical prisms will cause various overlappings of the double image and the displacements and manifest deviations up to five diopters will be regis-

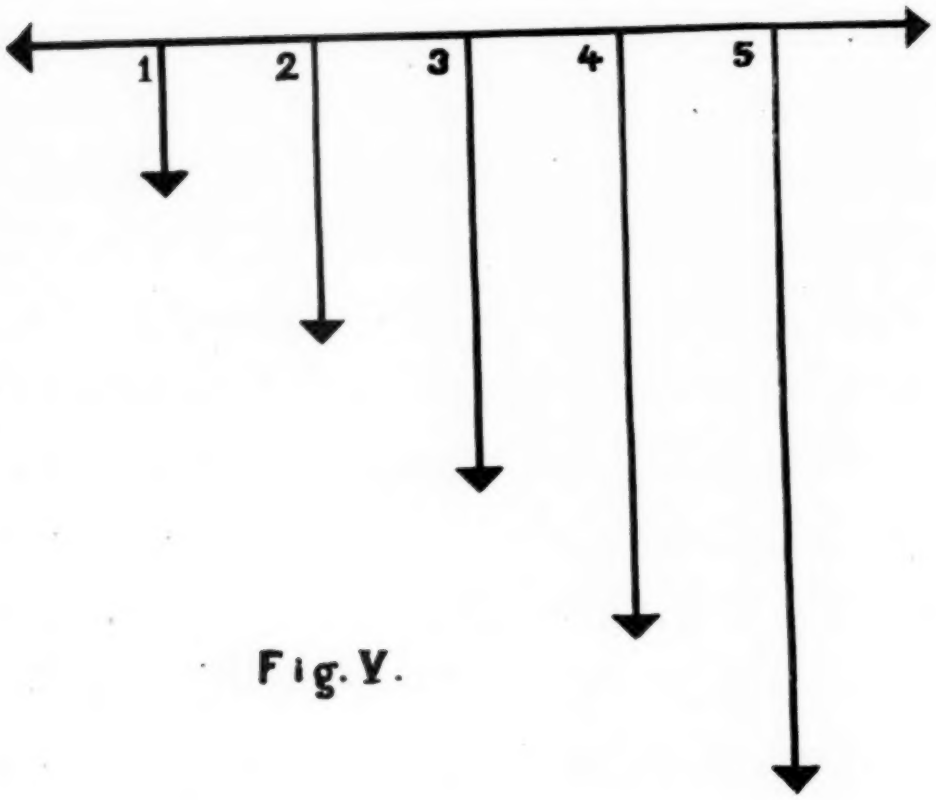

Fig. V.

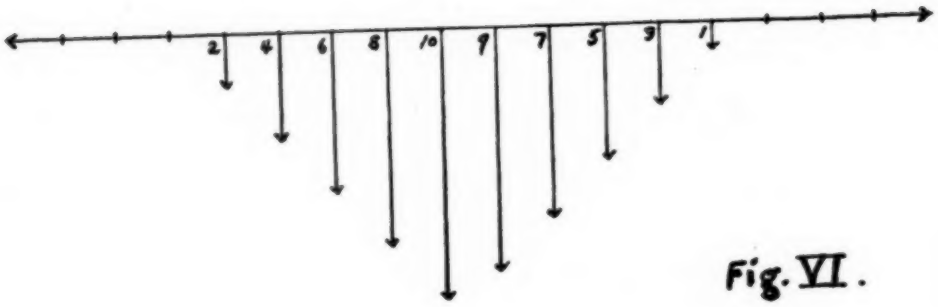

Fig. VI.

tered without the use of additional prisms.

Thus when a patient signifies that with the four diopter prism base-down over the right eye the upper image is displaced just enough for the point of arrow No. 1 to be coincident with the left end of the horizontal line of the lower image we know that one diopter of displacement has been caused and one diopter of exophoria is manifested.

The two millimeter width of the lines of this chart will necessitate fairly accurate accommodative adjustment while the numbers should be of such size as to subtend a five minute angle at the nodal points of the eyes under examination and thus the test will represent visual axes tendencies with minimal accommodative activity.

In Figure VI we have a representation of the chart to be used at 40 c/m and which in general is based on the same principles as the distant chart. All measurements in this chart should be one-fifteenth of those of the distant chart.

The spaces and the differences in length of the vertical lines represent the equivalent of two prism diopters.

It will be necessary to continually call attention, while making these measurements, to the fact that the patient must be able to read the numbers. Otherwise the accommodative adjustment may deviate from the plane in which the card is held.

It is apparently a very sensitive test and with an extensive array of data compiled it may lead to conclusions which will throw more light on the vertical and horizontal phoria ratio.

Though the writer has had considerable experience with this system of measurements he has purposely avoided sighting case histories for the simple and sane reason that not enough case records have as yet been established to justify any claims being made in its favor.

The primary purpose in presenting this paper is to persuade others to co-operatively carry on this experimental procedure deliberately and sincerely so that the greater number of case histories that will thus be made available will enlarge the scope of the analysis.

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ACCOMMODATIVE RELAXATION IN OCULAR EXAMINATIONS BY MEANS OF THE PARALLAX*

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The writer has studied, with some interest, the editorial by Koch in the December issue of the American Journal of Optometry, in which he comments on the cyclodamic method of estimating the error of ocular refraction as proposed by Dorland Smith. The suggested procedure seems highly complex requiring a most minute attention to detail in the arrangement of all conditions so as to encourage the continuous and cumulative relaxation of accommodation to that point where this relaxation is nearly or entirely total.

In this paper some new, or at least different terms are proposed for the several degrees or features of hyperopia, some of which disagree in amount, if not in type, with those more commonly designated. As a whole, the proposed procedure seems long and difficult and tiresome, both for the patient and the optometrist, and withal very hard to carry out, as well as open to the objectionable feature of receiving rather indefinite answers. This is the more apparent because both the patient and the optometrist are under a deep fog from which a certain arbitrary deduction of plus spherical power is to be made. Koch states that, " . . entirely dependable refraction requires the measurement of the total or real error, the full apparent error and the manifest error, involving three distinct types of examination under absolutely different types of accommodative activity necessary to obtain the findings."

It is almost needless to say that no busy refractionist will go to so much trouble, nor would more than one in thousands of his patients sit through such tedious work. Moreover, such metriculousness is, in the writers belief at least, needless, for the results attained would be largely fruitless.

After a careful study of existing techniques and apparatus the writer came to the conclusion several years ago, that not only could better instruments be devised, but that the intricate procedures now in use in refractive work could also be simplified. With this in mind the Parallax was devised. This instrument is to be used in connection with the Genothalmic Refractor as made by the Shuron Optical Company.

*Submitted for publication January 10, 1933.

Fig. 1. The Parallax in Use.

The device, illustrated in figures 1, 2 and 3, is instantly attached or taken from the refracting unit. I will describe this device, reference being made to figure 4, the graphical illustration of its several interior parts.

To obtain a satisfactory degree of rest, or relaxation of freedom from accommodative stress, and at the same time relieve the eyes of considerable additional stress due to convergence, has hitherto proved both impossible and impracticable. It is a basic fact that mydriatics and cycloplegics have little enough power over the ciliary body, except after prolonged treatment, but even under its most complete paralysis it still has no influence whatever over convergence, which means that the fusion faculty, instead of being subdued, is in full force.

Moreover, still greater difficulties have existed from the fact that it has beeen expedient to fog the patient by an overstrong lens, then

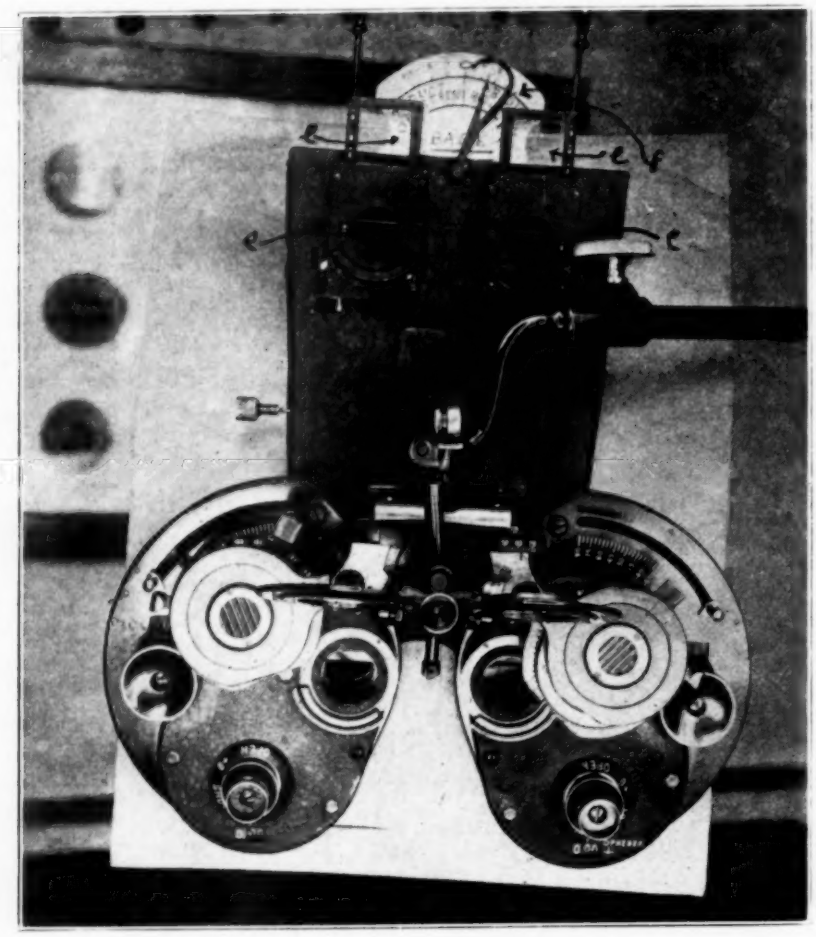

Fig. 2. View From Front.

gradually let down their accommodation during skiametry. This fog to the patient is also fog to the optometrist.

If the optometrist could fog the patient without also fogging himself, we would be able to carry out skiametric work with a high degree of accuracy, as is well known by all. And if to this desideratum we could arrange conditions so that *both* eyes of the subject could fix upon a distant object, much would also be gained. In all our present procedures this is a practical working impossibility, since the refractionist, in order to obtain a reasonably central reflex and also dodge about between the brilliant reflections of correcting lenses, will invariably get his head directly in the line of sight of the patient. Instantly there will

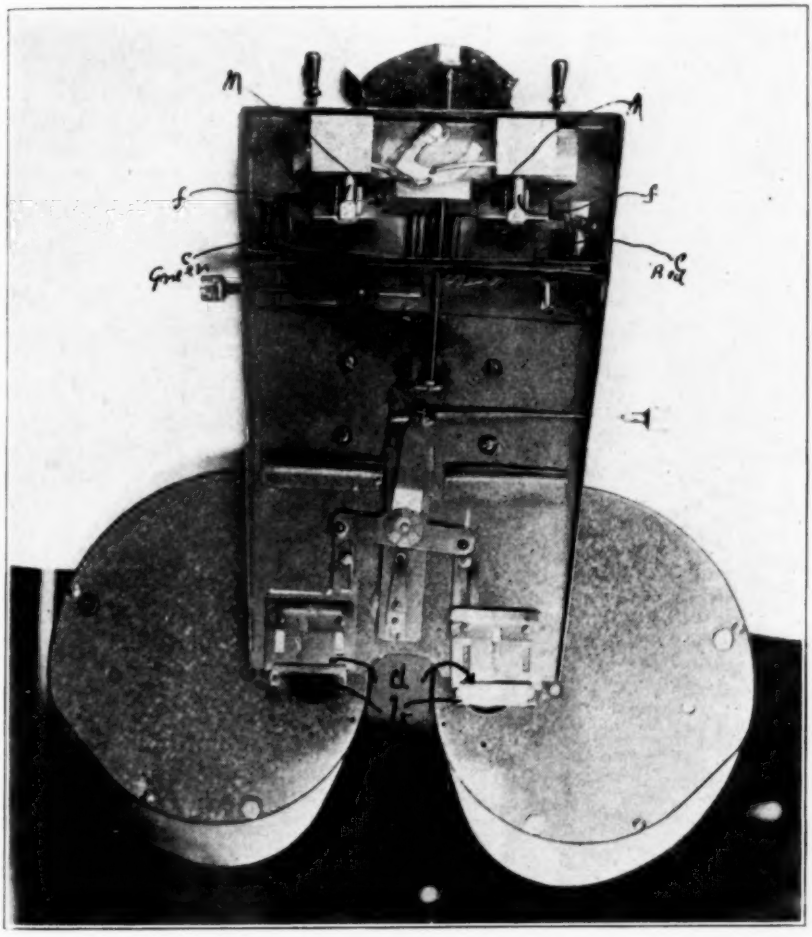

Fig. 3. View From Back.

be near-fixation, and the relaxed convergency of course instantly ceases, while some degree of accommodation takes place. Thus real relaxation and static skiametric determinations are interrupted and guessing has been introduced.

Moreover, it is manifestly a scientific impossibility for one to place himself directly in front of an eye and expect that eye to see at far distance, so that all the real distance seeing which is possible must be with the eye not under examination.

The Parallax is an instrument which has been undergoing development for some years, and is now ready for adoption. Essentially it is a periscope, or an arrangement of mirrors whereby the patient looks over

the head of the refractionist while he looks directly along the optical axis of the patient, hence the name, "Parallax," or parallel to the axis, but in reality exactly along the axis of either eye at will. The upper mirrors, two in number, are so arranged that they may be turned either toward each other, producing a base-out effect measurable in prism dioptres, or turned away from each other, producing a base-in dioptral value. We may thus at will restrain the convergence impulse, or stress it, either factor having its own personal effect upon such accommodation as is locked up with this individual's convergency—it being an established fact that this is a purely personal equation.

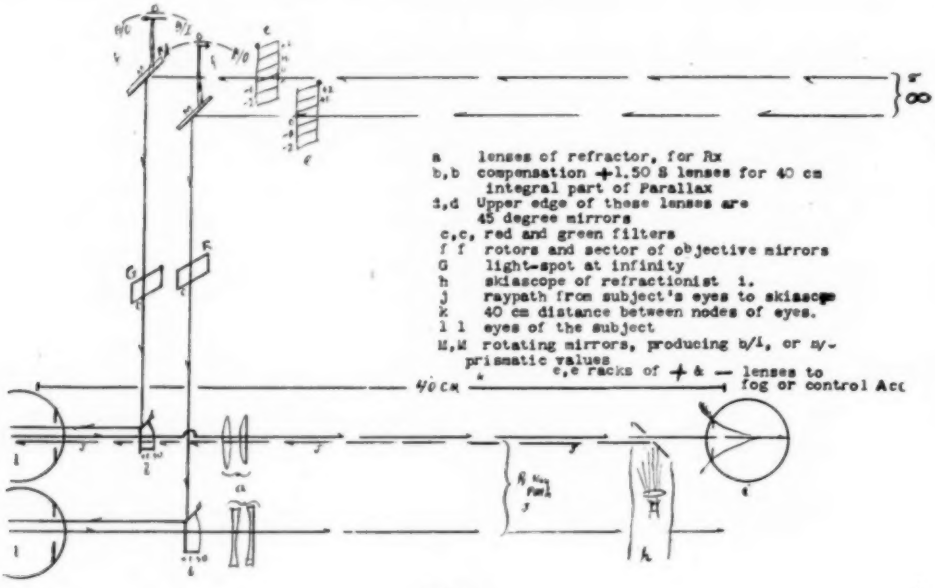
a lenses of refractor, for Rx
b,b compensation +1.50 S lenses for 40 cm integral part of Parallax
d,d Upper edge of these lenses are 45 degree mirrors
c,c, red and green filters
f f rotors and sector of objective mirrors
G light-spot at infinity
h skiascope of refractionist i.
j raypath from subject's eyes to skiascope
k 40 cm distance between nodes of eyes.
l l eyes of the subject
M,M rotating mirrors, producing b/i, or ay-prismatic values
e,e racks of + & — lenses to fog or control Acc
40 cm
∞

Fig. 4.

Moreover, a battery of + and — lenses, — (b) are placed in this upper visual pathway, so that the patient may be fogged to any extent, be given a strong lens if highly hyperopic, or a strong lens in high or low myopia, or any approximate astigmatic correction to permit of distance fixation, and all this accomplished in such manner that only the patient sees through these lenses, they being in an entirely different raypath than that through which the optometrist operates.

Therefore, with prism power available before both eyes, with any desired fogging or fixation power of lens, we may exercise an influence which no other instruments or attachments, and particularly which no drugs, have ever accomplished. But to these factors is added another of equally great importance, although as yet not generally known. This refers to the fact that an area of white light for distant fixation is caused to look like a red with a filter of mu 670 before one eye, and a blue-

green of mu 470 before the other (c). These are complimentary colors, producing the sensation of white when the areas fuse, but which may be readily separated from each other to any necessary distance by rotation of the index (f) which controls the vergency of the objective mirrors. When these mirrors are suitably rotated, fusion will break, and it takes definite convergence-relaxation to allow them to fuse into white. We mildly desire to see this object as white, but it is so readily broken down into its compliments of red and blue-green that the desire is strictly under control of the optometrist. These three factors of relaxation—fog, base-in, and complimentarism—give us a control never hitherto attained.

It is apparent now that the head of the refractionist is thus purposely placed in such manner as to definitely obscure the distant light from any possible sight by the patient through the usual lens apertures of the Genothalmic Refractor to which it attaches. Thus his own head performs a necessary function of compelling the patient to see along the upper ray-path. These lower, or ocular mirrors (dd), are fashioned upon a 45 bevel of some +1.50 S lenses, the power usually adopted to compensate for distance, the so-called "compensation lenses" (bb) and which value is subtracted from the skiametric determinations. When these lenses are removed, as they are by being released and drawn up into the sheath of the Parallax, after use, they are automatically subtracted, so that no calculations, either in spherical, cylindrical, or combination powers need ever be made, with the several chances of error which always exist.

Thus the refractionist takes a central position before the patient, his head being directly in the way of the patient who would otherwise see the fixation light through the refractor and causing her to see the colored lights in the upper ray-path. In this way the optometrist may use either of his own eyes, if he has a choice of one being better or more convenient than the other, and he refracts both eyes of the patient simultaneously, going from one to the other at will, comparing spherical powers, cylindrical powers, positions of axes and characteristics of the various shades of reflex.

He need not, as in present methods, reseat himself, change blinders before the patient, each time he wishes to change from one eye to the other. The old or present method frequently consumes a great deal of time since there is often either an apparent or possibly a real difference of considerable magnitude between subject eyes. We know that these apparent differences may be due to lack of fixation, lack of attention, change of fixation, change of accommodation of the patient, because of our own moving about and readjustment necessary to refracting the second eye. These changes take time, disturb optical relationships, and very frequently lead to large and costly errors. The Parallax obviates all this, since the eyes are refracted and compared simultaneously without the patient even being aware of it, their attention merely being fixed upon the two contiguous or fused colored lights.

The difficulties of accurate and practical static skiametry by present methods make it almost insuperable, as is the common experience, and a large number of men have practically abandoned or so modified it that in reality it is quasi-dynamic. And largely for this reason we find the statement that a deduction of from .50 to 1.00 D. and even more is arbitrarily made in every case as an allowance of error, under various terms. We know that the +1.50 compensation lenses usually used should theoretically be subtracted from findings for exact corrections, corresponding to a refraction distance of 40 c.m. or 26 inches (k), but when an arbitrary deduction is made in our wide experience of various types of cases, it has been axiomatic that something was radically wrong with our technique. How wrong we know only too well since such deductions are found necessary, or from the further fact that a large number of men have almost completely abandoned any attempt at worth-while static skiametric measurements, and have adopted what they have come to consider "dynamic" procedure.

With dynamic findings, by requiring fixation, and a degree of near-accommodation, it is customary for the refractionist to deduct some arbitrary amount such as 1.00 D., together with another equally erroneous and unwarranted amount which corresponds to the old table of accommodation for age. Thus two errors are introduced where there should be none at all. Skiametry finds itself in strict need of such checking by the subjective method that in reality we often wonder whether any part of the skiametric work is much else than a mere gesture with considerable swank. Fancy taking from gross skiametric findings of +3.50 D. Sph., +0.75 D. Sph. for some rather obscure or poorly understood instrumentation, together with an age 46 presbyopia. Who knows what the latter is, or the reason for the former, if there is any? Is it any wonder that skiametry is not as successful as it ought to be?

It is a well-known fact of physical optics, that the central area of spherical and compound lenses has an appreciably lower dioptral power than the peripheral area which portion normally increases in power in proportion to the distance from the optical center. Tscherning, Howe, and many other optical scientists have gone to much length in demonstrating, not merely by mathematics, but by very elaborate measurements of eyes, that the same law holds at least equally true in normal eyes, and is even much accentuated, due to the peculiar curvature of the cornea as we recede from its center.

From the fact that it is not only a practical but a physical impossibility to make a skiascopic measurement of the very center of sight, along the true optical axis, while expecting such an eye to fix at remotum, which must necessarily be exactly behind the head of the refractionist, rather than upon himself, with some consequent accommodation in play, it is self-evident that either the eye must fixate at distance in such a position that skiametric measurements are actually carried out in an area of appreciable distance from the center, if truly static, but if along the exact optical axis, then there must be a necessary play of some

amount of dynamics of the eye. Either of the facts account for an over-strong finding which leads to a considerable degree of inaccuracy.

With the Parallax we fog the patient without fogging our own vision. We produce diplopia, then just barely let them fuse. We add still further to this fusion impulse of accommodation by changing the white fixation light to two complimentaries which are not readily held in fusion by the vergency impulse. Under these conditions the skiametrist proceeds to refract the eyes successively and practically simultaneously without any handicap of being under conditions of fog himself because of over-strong lenses in the refractor necessary to hold the patient under fog, since the patient is fogged by the supplementary slides of lenses in the upper-ray path (ee). Thus, with the Parallax one may do in two, three, five minutes' time work which requires several times as much by the usual method, and accomplish it with far greater accuracy, obtaining a genuine static finding. It eliminates time and cuts fussing. Not merely does it not sacrifice to accuracy, but conduces to it immeasurably. If there is any tendency to eso/exo-phoria, either condition is instantly apparent not to the refractionist himself but to the patient since the fused spot of white light will instantly appear as two colored lights. If the red appears to be at the right of the green the optometrist may say to himself: "We quite possibly have here an esophore." But if the red is stated to be at the left of the green, he will likely remark to himself: "We probably have here an exophore." The Parallax, while not intended to replace in any measure the battery of prisms and other tests for balance and poise measurements, nevertheless is a quick check upon such conditions, and even reveals it to the patient at the beginning. Hyperphoria is as quickly observed, as it tells us which eye is up and which down without rules and references.

Static measurements having been made, which, as explained, are very quickly carried out, we wish at about the same time to complete our dynamic skiametric work while we are seated and instrument adjustments are already made. To do this we merely touch a spring in the Parallax which causes the ocular mirrors and their conjoint compensation +1.50 lenses (b and d) to rise up in the sheath of the Parallax, leaving in the cells of the phoroptor such power as the skiascopic procedure has shown for the distance correction. Upon this we now build up spherical power, not in accordance with any preconceived notions of the table of ages, for we give this no credence whatever, but add power while the patient is cautioned to attend strictly to fixation objects upon the stalk of the skiascope or other proximal object, until reversal is just beginning to show in first one eye, then in the other. If the powers do not agree spherically, or there is other astigmatic error than that found statically, we are at once appraised of these conditions. But the point to be made here is that dynamic, true dynamic findings, follow almost immediately after the static, and that if there are discrepancies which are not easily understood we go back to static work again by merely pressing down the lever which controls the ocular mirrors, bringing the red and green lights into view,

when we proceed to analyze discrepancies. The patient is not in any sense aware what we are doing, which is proper.

Static and dynamic findings having been found, approximations of ocular poise being appreciated, we are now prepared to check subjectively. If our work has been carefully done, we will find that the subjective "test" agrees very closely with the skiametric "examination." Such reductions of plus as may be found necessary are now almost invariably those which the natural tonus of a juvenile or youthful ciliary will tolerate.

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DISSECTION OF THE EYE AND A BRIEF REVIEW OF ITS ANATOMY*

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A matter of great concern at the present time in the profession of Optometry is the correct diagnosis and treatment of ocular innervational difficulties. Prominent men in the profession realizing the need for a more thorough knowledge of this special field of work, have given post graduate courses on such subjects as fusion training, and the diagnosing and treatment of convergence insufficiences. In order that we may carry on this movement toward a more complete and definite diagnosis of ocular anomalies associated with neuro muscular disorders of the brain, a thorough knowledge of the anatomical relationship between the eye and the brain is essential. It is fundamental that the physiologic relationship of the eyeball and the brain be well understood.

The accompanying photographs are pictures of the specimens that the writer presented for demonstration purposes before the New Jersey Optometric Association.

The purpose of this paper is to review this particular field of our knowledge and to stimulate further interest in it.

It would be well first to review the embryology of the eye.

Embryology:

There is a bulging out from the forebrain of the ectoblast forming the optic vessicle. Then the front part of it pushes backward forming a cup with an inner and outer layer. Then the short stalk in back of the cup stretches out and forms the optic nerve (made up of neuroglia tissue). There is a thickening of the ectoblast and the formation of the lens takes place right in front of the opening of the cup. The mesoblast surrounds the two layers of the retina forming the choroid and sclera. The vitrious is supplied by the lens and the retina. The mesoblast branches and covers the lens anteriorly and posteriorly forming the irrido pupillary membrane which nourishes the lens. In front of the lens the mesoblast forms the cornea. Later there is a separation of the cornea and the irrido pupillary membrane forming the anterior chamber

*An abridgment of the material presented before the New Jersey Optometric Association at Jersey City, N. J., November, 1932. Submitted for publication, January 26, 1933.

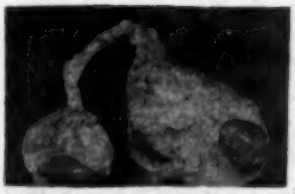

Fig.1. Two Optic Nerves and the Optic Commissure.

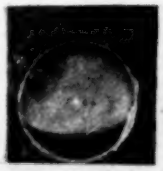

Fig.2. Posterior portion of Cow's Eye with Bulb Contents Removed Showing Choroid.

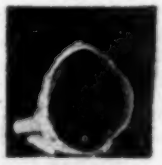

Fig.3. Cornea, part of Ciliary Body and the Anterior and Posterior Chamber.

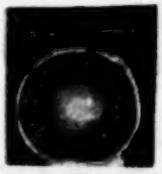

Fig.4. Anterior portion of Bull's Eye showing Lens, parts of Iris, Anterior Zone of Ciliary.

Fig.5. Retina with circulation easily seen.

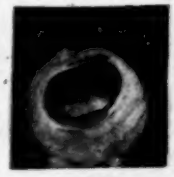

Fig.6. Retina has been removed and the iridescence of the Choroid can be seen.

NOTE:- In Figures 5 and 6, the Cornea, Aqueous and Lens have been removed.

Fig.7. Crystalline Lens split in half showing Stellate formation of Cells.

and atrophy of the membrane takes place forming the pupil. Through the optic stalk comes the hyaloid artery which nourishes the lens in the embryo but later atrophies. The mesoblast also forms the coats of the optic nerve (pia, arachnoid, and dura). The conjunctiva is formed from

the ectoblast. The central retinal artery is an outgrowth of the hyaloid artery.

Course of the Optic Nerve:

The optic nerve leaves the posterior pole of the eyeball and traverses the orbit through the intra orbital portion. Then it passes through the optic foramen. Soon after passing out of the foramen, it meets the optic nerve from the other orbit to form the optic commissure. From the optic commissure, optic nerve fibers travel in the optic tracts of the same side and the opposite sides. (Optic nerve fibers originating from the tempral field of the retina travel to the optic tract on the same side. The fibers from the nasal field cross.) They enter the brain stem in relationship with groups of nerve cells known as the primary centers of vision, namely: External Geniculate Body, Superior Colliculi and the Optic Thalmi. Then fibers go to the Optic Radiations to end in cells situated in the occipital lobe of the brain.

Bulbous Oculus:

Cornea: The living cornea is transparent and consists of five layers. The most important layer is the Stroma which makes up 90 per cent of it. This layer, by means of its many minute capillaries, nourishes the entire cornea.

Sclera: The sclera consists of dense fibrous tissue, an arrangement not laid out with thought of transparency but strength. It is poor in cell tissue but rich in fibers for protection. It is divided into three layers. At the entrance of the optic nerve the sclera breaks up into two parts, two-thirds of it is inverted back fusing with the dura mata of the optic nerve. The inner one-third forms the Lamina Cribrosa through which the optic nerve fibers pass.

Choroid: The choroid which consists of four layers, starts at the optic nerve and runs forward to the Orra Serrata. Its function is to serve as a nutrient organ to the retina, vitrious, and lens.

Examination Under Microscope: It consists mainly of blood vessels, united by delicate connective tissue containing numerous large, stellate cells (chromatophore cells). There is a layer of blood vessels and a layer of capillaries (chorio-capillaries).

Ciliary Body: The ciliary body extends backward from the base of the Iris to the anterior portion of the choroid. It is wider on the tempral side than on the nasal. It consists of non-striated muscle fibers arranged in bundles running in three directions (meridinal, circular, and radial).

Iris: The Iris originates from the anterior surface of the ciliary body. It consists of elastic connective tissue with thickly walled blood vessels. It is composed of three layers and has two types of muscles (sphinctor and dialator).

Retina: The retina consists of ten layers. It is attached at two places, namely: The Orra Serrata and at the Optic Disc. It is not firmly attached to the Choroid. It is transparent and kept in place next to the

Choroid by the vitrious. An interesting dissection is one where the retina is isolated from the rest of the specimen, after removing the vitrious and cutting away the sclera and choroid.

Examination Under Microscope: The second layer or the layer of rods and cones is an interesting one for study. At the periphery of the retina the rods are in excess to the cones in about the ratio of 16 to 1. Near the macula region the rods decrease and the cones increase. At the macula there are no rods.

Lens: The lens has an anterior and posterior pole. It is more convex posteriorly than anteriorly. It consists of a central portion, the nucleus and a peripheral portion, the cortex. It is enclosed in a capsule. It is made up of concentric laminae, hexagonal figures. These stellate figures can be easily seen when the lens is dissected in half. Fig. 7.

Aqueous. The Aqueous is a watery fluid which escapes from the anterior chamber, on dissecting away the cornea. It is a form of lympth which drains in and out of the eyeball through the spaces of Fontana.

Vitrious: *Microscope Examination:* It consists of a jelly-like fluid and is transparent. It is enclosed in a mesh work of very delicate fibrals. It has no blood vessels. The periphery is formed by the same fibrals but they are closer together, forming the Hyaloid membrane. The Vitrious can be removed from a specimen, first by cutting specimen in half and tilting it, and then by using a blow pipe (glass).

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SPINAL ANALYSIS IN ITS RELATIONSHIP TO CLINICAL OPTOMETRY*

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In his diagnostic work the modern optometrist makes use of many methods which at first sight do not seem to be related to his particular specialty, we may cite the use of the sphygmomanometer, urinalysis and iridiagnosis as examples. Although these are quoted as examples they are not given to indicate possible limitations, for it is the writer's firm belief that the practitioner should make use of any agent or diagnostic technique that permits him to give better service to his patients. Hence the heading and subject matter of this article. There is a great danger in modern specialization for the individual practitioner to neglect to note what the other fellow is doing, and nowhere is this more apparent than in our own work. We have evolved or improved certain instruments and appliances, and perfected techniques and there we seem to rest; anything outside what has been taught us at school or college is looked upon as outside the pale. Pure optometry is of course attractive, but a man does not long occupy his professional office before he realizes that his patients at times require something more than pure optometry to successfully solve some of their visual troubles.

It is with this in view that the suggestion is made that practitioners ought to make themselves familiar with certain of the diagnostic methods, such as spinal analysis, chromatic-reaction and analytical psychology, employed in the great non-medical colleges.

Spinal analysis when used by a competent osteopath proves its worth and soon establishes itself as a basic method.[1] We all know that the functions of the human body are intimately related to the spinal cord in one way or another, laboratories and clinics prove to the unprejudiced mind that the structures and relationships of the spine affect the health of the individual.

To get a clear understanding one must visualize the spine and its extremities as a whole and that trouble at one end will cause com-

*Submitted for publication December 29, 1932.

[1](The osteopathic diagnostic technics mentioned by Marton in this paper have been reviewed by Dr. Wm. Flory, Osteopathic Specialist, Medical Block, 608 Nicollet Avenue, Minneapolis, Minn., and conform to accepted osteopathic beliefs in America.) —C. C. K., Editor, A. J. of O.

pensatory changes or lesions at the other; a rotated fifth lumbar on the sacrum will cause compensatory lesions in the cervical vertebra which through their sympathetic control have a direct bearing upon the eyes. In view of this it becomes increasingly important that anyone who has to do with the public health as does the optometrist, should have at least a knowledge of Spinal Diagnosis.

In view of the foregoing it can be seen that to arrive at a complete diagnosis the entire spinal structure, bony, muscular, and ligamentous must be examined.

Three methods are used to isolate pathological areas in the spinal structure.

A. Inspection
B. Palpation
C. Percussion

The first step in inspection is to have the patient stand with their back toward you. It can then be seen if there are abnormal muscular contractions on either side of the spinal column, spinal curvatures, or a twisted pelvis. Next have the patient sit on a stool with his head flexed upon the chest and his back bent slightly forward. This flexes the spinal column and makes the spinous processes prominent. In this position separation or approximation of the vertebra can be noted as also any lateral deviations. With the patients spine still flexed, stand in front of them and look down the back in order to note any bulging of muscles on one side or the other. This will often point to the area of pathology.

With the patient sitting erect ascertain the flexibility of the spine. Note the position of the scapulae, whether near or far from the spinal column. Note any abnormal bulging of the shoulders close to the neck. This will often indicate a subluxed first rib, although usually the right shoulder will be higher due to abnormal muscular development in right handed individuals or vice versa. A lesioned first rib has a direct bearing on the third sympathetic ganglion.

Seemingly a person may be quite a healthy ordinary human being with a crooked spine. On the other hand should that spine be accompanied by concomitant signs indicating a disordered, nervous, vascular or lymphatic system, then the patient requires some form of treatment and as such treatment is not within the scope of optometry he or she must be referred to someone competent and qualified to deal with it. Usually inspection does not give us any information respecting the functional condition of the spinal cord, but it does give us a knowledge of spinal posture which has to be taken into account when examining by palpation or percussion.

The second and most important method of spinal diagnosis is palpation. To do this have the patient sit erect being careful not to exaggerate the normal posture. Use the index and middle fingers of the right hand, one finger on each side of the spine, and starting from the

first dorsal continue down to the fifth lumbar. Notice any lateral deviation of the individual vertebra. It is almost impossible to palpate the transverse processes of the dorsal and lumbar vertebra consequently one has as a guide only the spinous processes. As these are in some individuals abnormally crooked, they cannot be relied upon to indicate a deviated vertebra, other symptoms must be recognized. To the well trained fingers these symptoms are: abnormal contraction of muscles, a puffy feeling of the superficial tissues, swelling, increased temperature, and immobility of the lesioned vertebra. Pain or hypersensitiveness are always present about a deviated vertebra which can be determined by either light or deep pressure. Perhaps a better method to illicit abnormal contraction and sensitiveness is to have the patient lie on his side on a treating table and then palpate with the ball of the fingers the muscle along each side of the spine. A good indication of whether a muscle is contracted or not is by comparing it with the relaxed bicep muscle which is a very good indicator of what a normal muscle of the spine should feel like.

To palpate the cervical area, which is the most important from the optometric standpoint, the patient lies on his back, the examiner at the end of the table facing the patient's head. Here the transverse processes can be felt and are the best means of diagnosis. Using the index finger of each hand, starting from the first cervical, which can be felt just below and between the mastoid process and the angle of the jaw, go down each side of the neck palpating the transverse processes. Any cervical vertebra in lesion can be easily felt, not only by its abnormal structural relationship to the vertebra above or below, but also by the contraction of the muscles and accumulation of fibrous tissue about the subluxed vertebra. Pain, tenderness, and lack of motion are extremely important diagnostic points in cervical lesions.

It must be borne in mind that vertebral subluxations are not the only source of lesions in the spine. Muscular and ligamentous lesions are just as important and must be sought out and corrected by one qualified to do so. From the optometrists standpoint, suboccipital contractions are of great importance and are very common.

If there is interference in the normal nerve supply owing to tensed tissues the patient will feel pain on pressure. This constitutes the one sign used in percussion. However, percussion is the least important of all diagnostic means in spinal diagnosis. It is little employed any more by osteopathic physicians as its value is negative and just takes up time. It can either be done in the same manner as one would percuss the chest or by using a percussor.

The percussor is a small, well-balanced, rubber tipped hammer which can be applied directly to the spinous processes. For use on the transverse processes a bifurcated applicator is employed which is gently struck by the hammer. It can be inserted between each of the two adjacent vertebrae. When the patient complains of pain we know that we have isolated an area where there is something amiss and it may be that this very spot is capable of telling us what is causing the trouble about

which we have been consulted. Here is a case: Patient: male, age 46 years. Complained of headache and tired feeling. A normal presbyopia was present. The ophthalmoscope showed retinal hyperemia. Nothing of note was to be found in his color fields. Under percussion he complained of pains in the region of the tenth dorsal vertebra. Case was referred to a pathologist who diagnosed Bright's disease.

Or again, and here we can find this by direct palpation, if the patient exhibits pain and has stiff unrelaxed tissues in the lower dorsal and upper lumbar regions it is probable that he has some form of constipation. If, therefore, he presents a headache that may or may not be due to an ocular condition, we have here a differential diagnosis possible.

Just as pain under percussion is capable of showing us that something is wrong, so is its absence equally important. For normally, when pressure or a light blow of the percussor is made on a certain part which is healthy, it will be felt but will not hurt. Should no feeling of any kind be elicited we have a far more important sign, for this indicates that some form of paralysis is present and the patient is in urgent need of the services of a neurologist.

In order to give a clear outline of what one can expect to find in the normal spine we can list the following:

A. The articular processes of two vertebrae out of alignment.

B. The transverse processes not occupying the same plane, with greater separation on one side than the other.

C. The spinous processes of one vertebra out of alignment with those above or below it.

D. Contraction and diminished mobility of the tissues at one particular point of the spine.

E. Variation in local temperature of the spine. When there is an acute condition that region is usually warmer than the rest.

F. Pain and tenderness over lesioned area.

We have shown that lesions of a vertebra, either bony, muscular, or ligamentous will cause a disturbance of function of the nerve leaving that particular segment. As optometrists we are only directly concerned with the cervical area, indirectly with the entire spine in its relationship to the cervical area. We know that the spinal nerves are connected by rami-communicantes to the sympathetic nervous system and that impulses will travel through the whole sympathetic chain by its ganglion. A source of irritation to a lower sympathetic ganglion will more than likely affect the superior sympathetic ganglion in the cervical area. Surely abnormal conditions in the neck, bone and muscle lesions, will be bound to affect it.

The superior sympathetic sends branches upward which form a plexus around the internal carotid artery (carotid plexus). The cavernous plexus is a continuation of this. From this plexus many communicating branches pass to unite with the cranial nerves. Physiological

experiment has proven that this ganglion exercises a vaso-constriction influence over the blood vessels of the head and face. Terminal filaments from the carotid and cavernous plexuses are prolonged along the internal carotid artery forming plexuses around the cerebral and ophthalmic arteries, along the latter into the orbit where they accompany each of the subdivisions of the vessel, a separate plexus passing with the arteria centralis retinae, into the interior of the eyeball.

Reasoning from the position of the ganglion in the neck, its distribution to blood vessels of the head and face and its vaso-constrictor functions of these vessels, we can readily understand why mechanical lesions in the upper cervical area can be the cause of grave pathological conditions in the eye, as anything which disturbs the normal circulation in a definite area will necessarily affect the nutrition of the tissues in that area. Therefore, nutritional disorders of the eye are found to be caused by subluxations of vertebrae or contracted muscles in relation to the superior cervical ganglion.

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VITAMINS

Sheard, speaking on the biological effects of radiant energy before the American Academy of Optometry at Chicago last December, presented a somewhat new view[1] that he had reached regarding vitamins, through his extensive experimentation. It has been a long accepted fact, that the biological effect of the long invisible ultra-violet radiation of sun light, had certain beneficial properties to man generally known to accompany an increase of the vitamin D. Just what happened, when complex chemical substances were activated by the long ultra-violet radiations in this way, has been a subject for considerable discussion among scientists for years. Opinions have varied considerably, some being based upon mere speculation, others on more or less extensive clinical observation and experimental work. In the foreground of the latter group will be found Sheard, who, after several years of the widest type of experimental work in this field in the research laboratories of the Mayo Clinic at Rochester, Minnesota, comes to the following conclusions. He says in part that as the result of the experimental work carried out with my colleagues I have formulated the theory that vitamins are not necessarily new substances but may simply be certain atoms and molecules which have been photoelectrically or photochem-

[1]Sheard, C. Vol. VII. The American Academy of Optometry. p. 125. 1933.

ically activated. According to modern electronic theories, this activation of inert atoms and molecules may be conceived of as being due to the fact that energy contained within certain wave-lengths of radiant energy ionizes atoms in complex chemical substances and thereby endows them with new activities, properties and powers. After all is said and done, an ionized atom or molecule of calcium, phosphorus or what not is not the same entity as a nonionized molecule or atom, for the ionized molecule or atom has, figuratively speaking, its arms wide open to grab, whereas the nonionized substance has its arms folded and is, so to speak, at rest chemically.

Sheard continues, by saying that the vitamins such as vitamin D (as produced by the invisible rays of sunlight, carbon arcs or quartz-mercury lamps or as found in fresh, good quality cod liver oil) are doers, workers and energizers. They may simply be active forms of the mother substances, or, again, they may be catalyzers, i.e., substances that act as go-betweens, or handers-on, and which take the unavailable and make it available in some mysterious manner. Perhaps they are substances which act like the trigger in the gun, which, when it is pulled sets free the pent-up and previously unavailable energy of the gunpowder.

C. C. K.

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THE OPTOMETRIC USE OF THE AUDIOMETER

During the past several decades it has been the accepted custom, for at least some of the optometrists in every large center to supply electric hearing aids to various patients whose hearing was in some way impaired. Just why optometrists were originally selected or singled out to do this work by the manufacturers of these devices is perhaps, at the moment, besides the point. The fact remains that nearly all of these aids to hearing, in present day use, were prescribed by optometrists, thus making this service a more or less accepted part of optometric procedure. This being the case it is interesting to review the progress that has been made in this field, in the way of intelligently prescribing these aids to hearing.

In the past the work was largely done by the trial and error method of subjective clinical application. The patient was given a device; it was adjusted more or less carefully and both the examiner and the patient sat back to see or rather hear just what the results would be. No effort was made to study the patient's ability to hear and to carefully ascertain just what was necessary to improve this if possible. Nothing of the sort. Here was the instrument and there was a patient with a defect of hearing. If the patient could get some good out of the use of the instrument it was prescribed. If not, nothing was done to find out why he or she could not be given better service.

This naturally unsatisfactory and unscientific method of prescribing hearing devices left much to be desired. Patients whose defect of

hearing was such, that no existing device could possibly help them, were never so carefully examined so as to be told so, and therefore were left to wander around from one practitioner to another, spending their time and money for one examination and trial after another, always in the hope that perhaps some, still untried device, would be of benefit to them.

At this point the audiometer was developed. This instrument is useful in making and recording an accurate measurement of the quantity and quality of the auditory acuity, so that results of treatments and results of auditory examinations can be objectively observed. The instrument produces twenty-two tones, ranging from 32 to 16,384 vibrations per second, and the intensity of each tone can be varied at will, within considerable limits. In making an auditory examination a loss of low tones indicates, according to Bunch, a conduction deafness, while a loss of the high tones is characteristic of nerve deafness.

Now it must be understood that in order to hear ordinary conversation one must be sensitive to tones ranging between 300 and 3,000 vibrations per second. It must also be understood that electric hearing aids amplify all tones uniformly. These aids are, therefore, useful in that condition where the audiometric curve is moderately low and relatively flat. In other words these aids to hearing are of value when the general range of hearing has been uniformly reduced, a condition known as otosclerosis. On the other hand, where the curve is markedly irregular the hearing device will be of little or no value.

To explain this more clearly let me illustrate with a case of a patient who shows a marked loss of hearing in the speech range, but good hearing both above and below this range. This patient, suffering from what is usually a congenital developmental defect, will find an aid to hearing, useless. On the other hand a patient showing a general lowering of the auditory acuity, with a relatively flat audiometer curve should find a hearing aid of value. Obviously the patients general physical condition has a decided influence upon his subjective hearing.

As can be readily understood, the audiometer has therefore given the examining optometrist an opportunity to carefully study his patients hearing defects and to scientifically prescribe aids for these patients whose hearing can be most benefited by this means. It is necessary, however, for those optometrists engaging in this work to remember that as professional men it is their duty to first make sure that everything possible has first been done for the patient by medical specialists in this field.

C. C. K.

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PREPARING A SATURATED SOLUTION OF BORIC ACID

The most commonly used drug in ocular work, is, without a doubt, boric acid or what is sometimes called boracic acid. This is a mild and non-irritating antiseptic obtained by heating borax with hydro-

chloric acid and allowing the crystals to separate. When used in a saturated solution, it is, as a rule, a soothing efficient antiseptic wash for the eye.

From time to time patients inquire as to just the proper manner in which to prepare this solution. While this is more of a pharmaceutical problem than an optometric one, certainly no harm is done if the proper directions are given. In the writer's judgment at least the following points are important. In the first place considerable depends upon the make of powdered acid used. One must impress upon the patient the need for getting a high quality of boric acid; for instance, that prepared by some reputable chemical supply house. Once this is done the most simple method of preparing a saturated solution of boric acid is to take two bottles, fill one nearly full of boiled or distilled water, which has been allowed to cool. Next put in a lot of powder, more than will dissolve. Next shake the bottle well for a few moments and then allow it to stand over night. In the morning the undissolved crystals will be found at the bottom of the bottle and a clear solution can then be either siphoned off or gently poured off into the other bottle. The solution is now ready for use.

C. C. K.

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THE MEDICAL NON-OPERATIVE TREATMENT OF CATARACT

For the past twelve years certain ophthalmologists have experimented with various serum therapies to prevent, if possible the further development of senile cataract in those patients found to be suffering from this disease in its incipient stages. The treatment consists of prescribing injections of lens-antigen extract. This extract contains the lens-protein derived from the crystalline lenses of animals. These injections are usually given every other day, beginning with 0.5 cc. and increasing to 8 or 10 cc. or more, until some forty or fifty injections have been given, this number usually constituting the course of the treatment. After the injections are completed, either a 2 per cent solution of dionin is prescribed, or else the Weeks' boro-glycerin solution is ordered for the patient. The dionin to be used three times each week for a two-month period, stopping for a month and repeating this method indefinitely. The Weeks' boro-glycerin solution should be used daily and may also be continued indefinitely.

This form of treatment is based upon Roemers theory of senile cataract as a metabolic disease due to toxins in the blood, just as is diabetes. The lens-antigen extract is given to stimulate the formation of anti-bodies, which in turn act against these toxins in the blood. Lens-antigen extract not only incites the body cells to the formation of specific antibodies, but also creates a mild leukocytosis which tends to fortify the healthy lens fibers against toxins, while at the same time,

destroying or liquefying by cytolitic action the dead lens fibers. These dead lens fibers being recognized as cataractous material.

This method of medical non-operative treatment of cataract seems to be more or less beneficial in the ordinary gray appearing, senile cataract case, especially when used in the early stages. In 1931 Davis reported on some 420 cases treated by this method. Of this numbr some 80 per cent showed an arrested development of the disease, and in about half of these cases the visual acuity improved after the treatments.

It is interesting to compare these findings with those presented by Hotaling[1] in his optometric non-operative cataract treatment technic in which he uses Calobar lens therapy. His findings indicate a similar percentage of success as obtained by Davis. Both men attained about the same measure of success despite the fact that their technics were in no way similar nor were the theories the same, upon which their work was based. In either technic, however, it is essential to emphasize the importance of an early diagnosis and an early treatment.

C. C. K.

BOOK NOTICES

OPTICKS, OR A TREATISE OF THE REFLECTIONS, REFRACTIONS, INFLECTIONS AND OF LIGHT, BY SIR ISAAC NEWTON. Published by the McGraw-Hill Book Company, Inc., 300 West 42nd St., New York, N. Y. 414 pages, Cloth 1932. Price $2.50.

This book on Opticks is an exact reprinting from the fourth edition which was published in London in 1730, three years after Newton's death. The book has a foreword by Prof. Albert Einstein.

In Opticks, Newton describes fully all of his optical theories and gives experimental proof about his propositions. He carried out a large amount of original experimental work on light and with his discoveries he was able to explain many of the phenomena of light for the first time. For instance, by the discovered properties of light, he explained the colors made by prisms. One can hardly find space in an ordinary review to enumerate the many points and the numerous interesting observations which Newton describes. Einstein, in his foreword, perhaps covers this best when he states that: "Newton's discoveries have passed into the stock of accepted knowledge. This new edition of his work on optics is nevertheless to be welcomed with warmest thanks, because it alone can afford us the enjoyment of a look at the personal activity of this unique man."

J. I. K.

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[1]Use of Calobar Red-Free Absorption Glass in Certain Cataract Cases. American Journal of Optometry. Vol. 10, No. 3, p. 104.

TELEVISION, ITS METHOD AND USES, by Edgar H. Felix. Published by McGraw-Hill Book Company, Inc., New York, N. Y. First Edition. 272 pages, 73 illustrations. Cloth 1931. Price $2.50.

The author tries to explain the stumbling blocks that are in the way of the proper development of television. He does not want the reader to be deceived and think that the perfect television era is at hand. He fully realizes the difficulties to be overcome and in this book, Television, he explains fully the problem of visual-image transmission and describes the hardships that are encountered. He discusses the function of the eye in performing the act of vision and describes the different phenomena involved. He points out that with the present state of development it is impossible to transmit the object lying in the entire visual field as a single electrical impulse, as is the case in actual everyday seeing. It is therefore necessary to break down the subject of transmission into "picture elements." This, the author calls *scanning*. He explains clearly how this act of scanning is performed and points out that the electrical communication circuits involved are analogous to the rods and cones of the eye, which transform light energy into electrical impulses suitable for transmission to the brain.

The author, in explaining the many different phenomena involved in the process of television, shows that he has a clear understanding of the subject. His subject matter is well organized and the material is presented in a clear and understandable form. J. I. K.

ELEMENTS OF OPTICS, Second Edition, by Joseph Valasek, Ph.D., published by the McGraw-Hill Publishing Company. 254 pages. 145 illustrations, $2.25, 1932.

Professor Joseph Valasek aimed to give a clear cut and comprehensive idea about the newer aspect of optics, the recent developments as well as the old established principles. He describes fully in the first six chapters light and its propagation, photometry, velocity of light, reflection and refraction. In chapters seven and eight he treats, at length, different types of lenses and optical instruments. The next five chapters are given over to a discussion of color, color mixture, color vision, interference, diffraction, double refraction and radiation. The last two chapters contain a brief but clear review of the "Theory of Relativity" and about the nature of light.

The book was written primarily as a manual for students, the author, however, tried to keep out all advanced mathematics, so that anyone with knowledge of algebra, geometry and trigonometry will have no difficulty studying this valuable text.

J. I. K.

ANNOTATIONS
AND
SOCIETY PROCEEDINGS

The American Journal of Optometry is the Official Organ of the American Academy of Optometry, as well as the Organ of the Arkansas, Delaware, Indiana, Iowa, Maine, Maryland, Michigan, Minnesota, Nebraska, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont and West Virginia Optometric Associations.

The following gentlemen have consented to supply items of interest from their respective sections, acting in the capacity of

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CRUSADE FOR QUALITY

The Riggs Optical Company, the Colonial Optical Company, McIntire, Magee and Brown, the Southeastern Optical Company, White-Haines and the Associated Optical Company have banded together for the purpose of making a national drive at the present time to impress upon the public and all refractionists, the need for using only ophthalmic material of good quality. These optical laboratories, realizing the tremendous harm which is being done by the use of cheap inferior materials, are, at this time, graphically illustrating to all of their respective customers, the evils of using poor and inferior materials, in the actual harm done the patient and also in the loss of confidence which results from the prescribing of the poorer grades of material. These laboratories and wholesale houses are urging the optometrist to talk quality, to show his patients good materials and to suggest their use and to, in every way, educate the public to know the difference between the inferior and standard grades of optical material. These firms are doing their part in this splendid movement. Professional optometrists throughout America should see to it that they subscribe, by their actions, to this piece of good work which will result in reposing a greater measure of confidence in them and their work.

C. C. K.

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WEST VIRGINIA OPTOMETRIC ASSOCIATION

The annual meeting of the West Virginia Optometric Association will be held at the Daniel Boone Hotel at Charleston on the 21st and 22nd of May. Dr. A. M. Skeffington will be the chief speaker.

RESEARCHES IN PHYSIOLOGICAL OPTICS

Robert H. Peckham of the Graduate School of Psychology of Johns Hopkins University presented a paper on "A New Precision Stereoscope and Objective Technique for Investigating Problems in Vinocular Vision," before the Southern Society of Physiology at their recent meeting in Washington, D. C.

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OKLAHOMA OPTOMETRIC ASSOCIATION

At the Thirty-eighth Annual Convention of the Oklahoma Association of Optometrists, Dr. R. A. Dieman was elected president, Dr. W. R. Nelson, vice president, and Dr. E. B. Alexander, re-elected secretary and treasurer. Dr. Thos. McBurnie and Dr. J. C. Copeland were the speakers.

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SOUTHEASTERN CONGRESS OF OPTOMETRY

The Southeastern Congress of Optometry will be held at the Suwanee Hotel, St. Petersburg, Florida, May 28 to 31. The speakers at this gathering of optometrists from eleven states will be Drs. Skeffington, Clason McBurnie and Micholson. Dr. Esther M. Ingram is in charge.

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MINNESOTA ANNUAL CONVENTION

Dr. Walter Nordin of Austin was elected president of the Minnesota Association of Optometrists at its recent annual meeting at Minneapolis. Dr. Harry L. Foug of Los Angeles was the chief speaker.

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NEW MEXICO BOARD OF EXAMINERS

The New Mexico Board of Examiners in Optometry has just been reorganized. Dr. C. A. Staellin, president; Dr. S. N. Hancock, vice president, and Dr. C. E. Worrell, secretary and treasurer. Examinations were held at Albuquerque on the 10th and 11th of April.

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SOUTH DAKOTA OPTOMETRIC ASSOCIATION

Dr. Harry L. Foug and Dr. John Copeland were the speakers at the Twenty-fourth Annual Meeting of the South Dakota Society held at Watertown. Dr. R. G. Colberg was re-elected president, and Dr. W. H. Fritz re-elected secretary.

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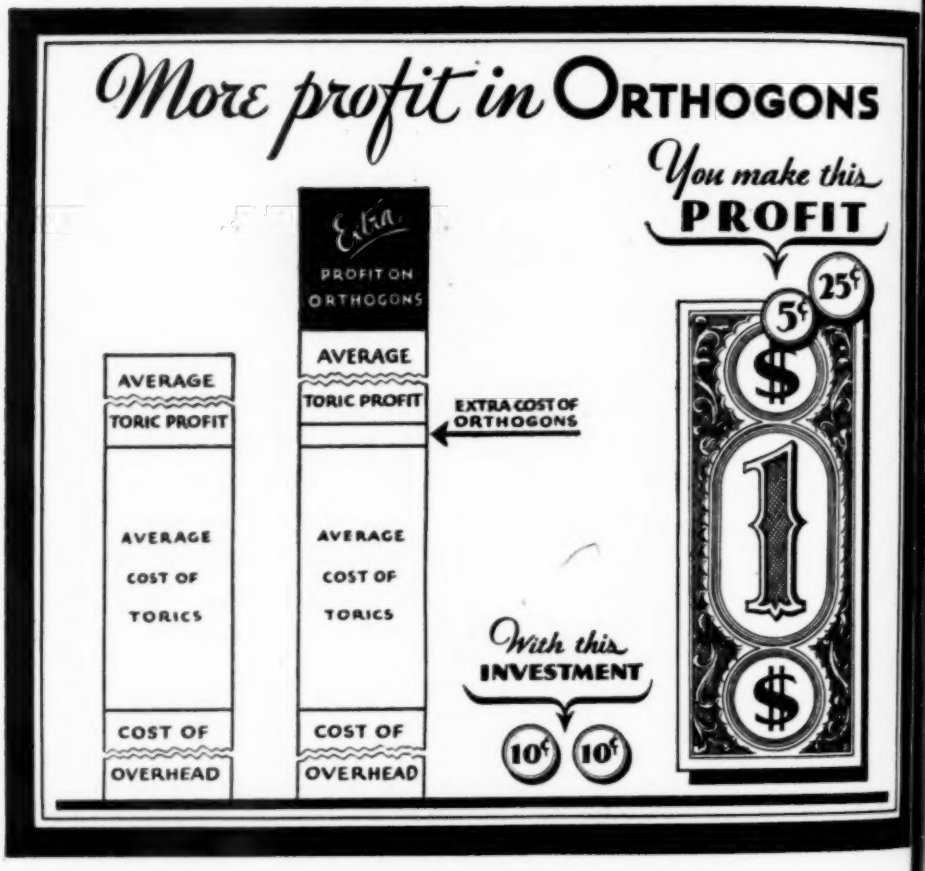
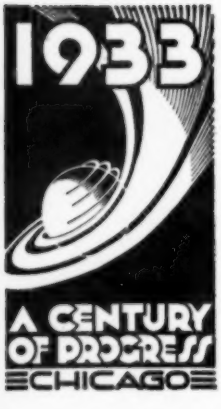
ATKINSON SUMMER COURSE

A graduate course for optometrists will be held in Chicago by Dr. T. G. Atkinson during the summer months. Complete outlines of subjects covered with their dates will be sent on request, by the chairman, Dr. P. N. DeVere, 1032 East 46th St., Chicago, Ill.

ORTHOGONS yield profit where





See our exhibit in the Hall of Science.

THIS chart represents actual figures. Lettered areas indicate present overhead of any given office, the average cost of torics, the average toric profit. In the taller column is shown the small average *extra cost* of Orthogons; the *extra Orthogon profit* is in black, regardless of overhead and toric profits, which, in both cases would remain the same.

This is even more strikingly illustrated at the right. The average added cost for a pair of Orthogons is *less* than 20 cents; the added income averages more than $1.30

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